

Appl. No. 10/030,867
Amtd. Dated February 27, 2004
Reply to Office Action of December 2, 2003

Attorney Docket No. 81839.0105
Customer No.: 26021

REMARKS/ARGUMENTS

Claims 1-5 are pending in the application. By this amendment, claim 1 is being amended so as to depend from and add some of the limitations thereof to claim 4. No new matter is involved.

In paragraph 2 which begins on page 2 of the Office Action, claim 1 is rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent 6,458,202 of Kojima et al. While not specifically stated, the following discussion also extends to claims 2-4, so that it is assumed that these three claims are also rejected on the same grounds. In paragraph 3 which begins on page 4 of the Office Action, claim 5 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Kojima et al. as applied to claims 1-4, and further in view of JP01040668 of Ito. These rejections are respectfully traversed.

However, in order to more clearly distinguish the present invention patentably over such prior art, applicant is amending claim 1 so as to depend from and add some of the limitations thereof to independent claim 4. Claims 2 and 3 continue to depend from claim 1, while claim 5 continues to depend from claim 2.

Addressing first claim 4 which is the only independent claim remaining in the application, the prime feature of such claim is a method for growing a semiconductor single crystal according to the Czochralski method utilizing an apparatus for producing a semiconductor single crystal, wherein the apparatus is provided with subsidiary heating means below the crucible, and after a grown single crystal is detached from the melt and taken out from the apparatus for producing a crystal, a raw material is newly added to the raw material remained in the crucible and melted, and when a seed crystal is brought into contact with the melt to pull a single crystal again (i.e., in multi-pulling), the crucible is heated by

the heater surrounding the crucible and the subsidiary heating means so that the raw material melt should not be solidified at least for a period from the point of the detachment of the single crystal ingot to the point of complete melting of the raw material in the crucible including the raw material newly added thereto.

As described from line 20 of page 20 to line 5 of page 21 of the specification, in the multi-pulling, when the raw material is additionally introduced, if the raw material melt completely solidifies in the crucible, a stress is applied to the crucible by the volume change at the time of solidification, and the crucible may be cracked. However, and as set forth in claim 4, wherein the crucible is subsidiarily heated from below for a period from the point of the detachment of the single crystal ingot to the point of complete melting of the raw material in the crucible including the raw material newly added thereto, occurrence of solidification can be prevented even for a small amount of melt remaining in the crucible. As a result, the raw material can be introduced at a high introduction rate, cracking and deformation of the crucible can be prevented, and moreover, the amount of the melt remaining in the crucible can be made small. Therefore, a single crystal can be obtained with a high yield (see line 21 of page 12, line 7 of page 13 and lines 6-26 of page 21 of the specification).

Kojima discloses, in the abstract, in Fig. 3, and at lines 16-36 of column 10 thereof, that when pulling a silicon ingot by a CZ method, the power supply to the side heater is maintained constant throughout the growth of the main body and end cone of the ingot, and the power supply to the bottom heater is gradually increased during the second half (after about 40% - 60%) of the main body to end cone. However, Kojima does not refer to the multi-pulling, as in claim 4 of the present application, wherein ingots are continuously pulled while the raw material is additionally introduced. Instead, it only teaches that when one ingot is pulled from

the melt in a crucible, the power supply to the bottom heater is gradually increased during the second half of the growth process. Namely, Kojima discloses that the bottom heater is used only in the growth of the crystal, and neither teaches nor suggests that in the multi-pulling, the crucible is heated by both the side heater and the bottom heater for a period from the point of detachment of the single crystal ingot to the point of complete melting of the raw material in the crucible, including the raw material newly added thereto.

Ito teaches, in the PURPOSE of the Abstract, that to rapidly and effectively melt the raw materials in a crucible, the raw materials are melted while independently controlling side heaters and bottom heaters. However, Ito neither discloses nor suggests the multi-pulling, but only teaches that side heaters and bottom heaters are used when melting a raw material charged in a crucible 2 in advance, as shown in Fig. 3, i.e., used in the initial melting.

Thus, as described above, Ito teaches that side heaters and bottom heaters are used when initially melting a raw material (initial melting). On the other hand, Kojima teaches that the side heater is used in the first half of the growth process of the ingot after melting a raw material, and the side heater and bottom heater are used during the second half of the growth process of the ingot after melting a raw material. However, none of the references teach or suggest the multi-pulling. Therefore, even if Kojima is combined with Ito, all that is accomplished is a method that when a raw material is initially melted, based on Ito, the raw material is effectively melted by using the side heater and the bottom heater. Furthermore, when an ingot is grown after the melting, based on Kojima, a crucible is heated by only the side heater during the first half of the growth process and the crucible is heated by the side heater and the bottom heater during the second half of the growth process to grow one ingot. Therefore, the combination of references cannot

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arrive at a method as in the present invention that in the multi-pulling, the crucible is heated by both the side heater and the bottom heaters to prevent deformation of the crucible or the like for a period from the point of the detachment of the single crystal ingot to the point of complete melting of the raw material in the crucible, including the raw material newly added thereto.

The invention as defined in claim 4 can be derived only from recognizing the problem peculiar to the multi-pulling of the present invention, i.e., the problem that when a raw material is additionally introduced, the raw material melt may be completely solidified and the crucible may be cracked, and in addition, finding that when the crucible is heated by both heaters for a period from the point of the detachment of the single crystal ingot to the point of complete melting of the next raw material, cracks in the crucible can be prevented.

Therefore, claim 4 is submitted to clearly distinguish patentably over the references, neither of which teaches nor suggests even the multi-pulling. The method in accordance with the invention has the advantageous effects that cracking of the crucible is prevented and a single crystal can be obtained with a high yield.

Claims 1-3 and 5 depend, directly or indirectly, from claim 4 and contain all of the limitations thereof, so that such claims are also submitted to clearly distinguish patentably over the references.

In conclusion, claims 1-5 are submitted to clearly distinguish patentably over the prior art for the reasons discussed above. Therefore, examination and allowance are respectfully requested.

If for any reason the Examiner finds the application other than in condition for allowance, the Examiner is requested to call the undersigned attorney at the Los Angeles, California telephone number (213) 337-6846 to discuss the steps necessary for placing the application in condition for allowance.

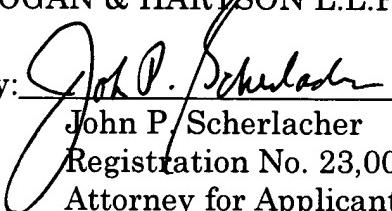
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Respectfully submitted,
HOGAN & HARTSON L.L.P.

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